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REPORT

ON THE

e and Hiwassee Mineral District.

BY

J. B. KILLEBREW,

Commissioner of Agriculture, Statistics and Mines.

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To His Excellency, Gov. Jas. D. Porter :

Herewith is submitted a report on the Mineral District, drained by the Ocoee and Hiwassee rivers, one of the most valuable and important in the State, and one about which capitalists are eagerly seeking information.

I have the honor to be,

Very Respectfully,

J. B. KILLEBREW.

October 16th, 1876.



OCOEE AND HIWASSEE MINERAL DISTRICT

There is no region in the State of Tennessee containing a larger number of valuable minerals than that drained by the Ocoee and Hiwassee rivers. Here, within an area of 2,000 square miles, may be found gold, lead, copper, iron, roofing slate, lithographic stone, marble, and baryta, all of considerable economic value.

The following counties, or parts of counties, were included in the Ocoee and Hiwassee districts, viz: Monroe, Polk, McMinn, Bradley, James, Meigs, all that portion of Hamilton lying east of the Tennessee river, and the portion of Roane lying south and east of the same stream.

The Hiwassee district, lying east and north of the Hiwassee river, and extending north and west to the Tennessee river, was ceded to the United States by treaty with the Cherokees, confirmed by the Senate 19th March, 1819.

The Ocoee district, lying south of the Hiwassee river, was acquired from the same tribe of Indians by treaty bearing date 23d May, 1836.

The topography of this region is exceedingly varied. The mountains on the south-east are lofty and imposing, rising to the average height of 3,500 feet. Between the Little Tennessee and the Hiwassee rivers, occur Hangover's Knob and Haw's Knob, that have an elevation of over 5,000 feet. Tellico Bald, in Monroe county, has an elevation of 4,266 feet. Frog Mountain lies south of the Ocoee, its highest peak being, according to Guyot, 4,226 feet above the sea.

Between this line of peaks, which runs north-east and south-west, is a depression, or elevated mountain valley, which lies between the main Unaka range on the south-east and the Chilhowee range on the north-west. This Chilhowee range is a succession of sandstone mountains, ridgy or camby in form, the highest points of which reach about 2,500 feet above the sea. In this range is included the Chilhowee Mountain proper, which begins five or six miles west of Sevierville and passes through Blount county, terminating at McGhee Ford, on the Tennessee river. The Guide Mountain, in Monroe county, belongs to the Chilhowee range, and is included between Ball Play creek and Tellico river. Eight or ten miles to the south-west, in the same line, is Star Mountain, that lifts its bold crest proudly above the valley and terminates at the Ocoee river, being eighteen miles in length.

These three mountains, viz: Chilhowee, Guide Mountain, and Star Mountain, make up the Chilhowee range, and are outliers of the main Unaka chain, and are separated from it by a mountain depression, which is some eighteen or twenty miles wide. The Unaka chain may be considered the middle belt of the Appalachians—the Cumberland Table-land lying to the north-west and the Blue Ridge to the south-east. Lying south-west of the Chilhowee range is a series of minor ridges and valleys running north-east and south-west. Some of these ridges are dissected, forming beautifully rounded hills, with a wonderful regularity as to height, size, and distance apart. The tops of these hills are from 300 to 400 feet above the level of the valley. They have a deep red ferruginous soil, highly productive, though owing to their steepness, the soil soon washes down into the valley. These knobs constitute one of the principal topographical features of this region.

Between these minor ridges are valleys averaging in width from one to two miles, in which the soil is of exuber-

ant fertility. The ridges are mainly composed of chert, and have poor soils and a scanty supply of timber. There are some exceptions, however, to this. Eastanallee ridge, in McMinn county, possesses a generous soil, and is covered with a dense forest. The principal streams of this region are the Hiwassee, the Ocoee, Tellico, Conesauga, Chestua, Eastanallee; the Hiwassee being the main artery into which all the others flow, with the exception of the Tellico, which is the tributary of Little Tennessee. The Hiwassee rises in North Carolina, on the western side of the Blue Ridge, and runs north-west at right angles to the Unaka range, cutting through it in deep narrow gorges, some of these being over a thousand feet deep. It also bisects Star Mountain, cutting gorges through the minor hills, and finally pouring its waters into the Tennessee river, forty-five miles above Chattanooga. The Hiwassee is navigable for a distance of 33 miles during nine months in the year, the head of navigation being the point where it leaves Star Mountain. The Ocoee, a tributary of the latter, rises in Georgia, flowing quietly in a north-westerly direction through Copper Valley, in Polk county, after passing which, it cuts through Frog Mountain, one of the peaks of the Unaka range. For fourteen miles after leaving Copper Valley the stream is confined by high towering and often overhanging precipices, falling within this distance more than 1,000 feet. The current is vexed by huge boulders that have tumbled down into the channel. The whole river through this distance forms a succession of cascades, whose thundering roar may be heard for miles, and well justifies the name of the Ocoee or "Roaring River." After passing the mountains it becomes a very quiet, gentle stream, winding beside broad fertile valleys and supplying some of the most valuable water powers in the State. Its average width in the mountains is about 85 feet, but lower down it spreads out to a width of 145 feet. Though a tributary of the Hiwassee, the depth

of water for eight or ten miles above the mouth is much greater than that of the main stream. It is navigable for three or four miles above its mouth, and but for the mill-dams and overhanging timber, it might, at a small expense, be made navigable to the mouth of Cook's Creek, some eight miles from its confluence with the Hiwassee.

Tellico river has its head waters in the Unaka Range, runs north-west to Tellico Plains, and thence it takes a northerly direction, emptying into the Little Tennessee, fourteen miles from its mouth. This stream, after leaving the mountains, passes across the country through a succession of rich valleys, some of them very wide and productive, and especially adapted to the growth of Indian corn, wheat, oats, rye, and Irish potatoes. The banks of this stream are usually of hard rocks, and the fall is very rapid and the water of unusual transparency. No stream in the State supplies more excellent water powers, some of which will be described further on in this work.

The Conesauga, Chestua, and Eastanallee, all tributaries of the Hiwassee, flow down parallel valleys at right angles to the mountain stream. The valleys bordering these creeks are noted for the fertility of their soils and for their width and beauty. These streams are usually sluggish and have mud banks, and though supplying some good water privileges, are inferior to the other streams heretofore mentioned. In their appearance they resemble the streams of West Tennessee, having tortuous channels, with deep cut banks and feeble currents. The ridges which bound them are sharp and persistent. After heavy rains these streams often rise in fearful torrents, sweeping away fences and even houses upon their banks.

The geological formations of the region under consideration are as varied as the topographical features. Beginning on the south-eastern side of the district, two triangular patches occur, one in the south-eastern part of Polk county,

comprising about 54 square miles, and another in Monroe county, of 42 square miles, which belong to the metamorphic formation. The rocks of this formation are mostly crystalline, occurring in stratified beds. Gneiss, syenite, talcose-chloritic and mica-slates constitute the principal varieties. Veins of milky quartz are often found interstratified with the other strata mentioned. All the strata dip at a high angle to the south-east. In the metamorphic formation the copper ores occur, which will be spoken of more in detail hereafter. Gray and flesh-colored gneiss is found, which might be made valuable for building purposes, if the means of transportation were afforded.

Lying to the north-west of these two patches of metamorphic rocks, and forming a continuous band or strip fourteen miles wide, is the Ocoee group of the Lower Silurian. The Ocoee river cuts through this group and exposes the coarse, gray and reddish conglomerates alternating and interstratified with chloritic-talcose and argillaceous-slates. These slates are green, light blue, or black. Sometimes the conglomerate runs into a coarse sandstone. In the conglomerate the pebbles are quartz, sometimes white, again a jaspery color, often rounded, but sometimes angular. A beautiful variation is often given to the bluffs of conglomerate by seams of quartz, which occur both in fissure veins running unconformably to the strata, and sometimes in regular strata. Dr. Safford puts the thickness of the Ocoee group at 10,000 feet. The only difference between this group and the metamorphic is, that the latter has undergone a baking or heating process, and has thus been changed into crystalline rocks. These Ocoee rocks in the district under consideration, embrace quite six hundred square miles. In this group are found valuable deposits of brown hematite, and roofing slates. The gold region on Coco Creek also occurs in this formation. Pyritiferous slates are also found, and but for the disintegrat-

ing effects of the pyrite, might be valuable for roofing purposes. At Mundic Bluff I obtained some fine cubical specimens of pyrite from the slate. The slates here are pock-marked by the falling out of the cubes of pyrites whenever exposed to the action of the weather.

The conglomerate at places forms high bluffs. At one point, twelve miles below Ducktown on the Ocoee, it rises five or six hundred feet, which causes the river to make a sharp curve. Dressed, this rock would make quite a handsome building stone and very durable. It weathers well. The rocks excavated at this point twenty years ago, show the sharp edges as clearly marked as when first quarried.

As a grazing region this formation offers some superior advantages. The wild mountain grasses cover the sides and tops of the mountains, and the numerous springs that break out from every cove furnish an abundance of the purest water. The air is bracing, and all kinds of stock fatten well during summer.

The timber is of medium quality, composed mostly of chestnut, hickory, and pine, both white and yellow.

The belt lying on the north-west of the Ocoee group is made up of the Chilhowee sandstone and the Knox Group; the latter comprising sandstones, shales, and magnesian limestone. The Chilhowee sandstones are confined to the Chilhowee range heretofore mentioned, and are usually hard, semi-crystalline red-variegated rocks, heavily bedded, that resist the weather probably better than any rocks in the State. They are essentially mountain-making. Sandy shales and flagstones containing mica are often found interstratified. But few signs of fossils are found—the principal being the holes of *Scolithus linearis*, filled with sandy rods. These mountains are singular on account of the abruptness with which they rise up in the surrounding plain.

It must be remembered that the Chilhowee range lies on the north-west side of the principal axis of the Unakas, and

reaches from Johnson county to Polk. This range is made up of a series of usually sharp-topped mountains, separated by inter-vales, sometimes of fifteen or twenty miles, yet the range preserves its own direction. The inter-vales in the Ocoee and Hiwassee district belong to the Knox group, which are made up of sandstones, shales, dolomites, and limestones. The Knox sandstones and shales make up the many sharp-crested ridges that rise up in the valleys. The soil of these ridges is, for the most part, thin and unproductive. The rocks of the valleys are limestones and dolomites. The Conesauga Valley is based mainly on the Nashville and Trenton rocks. This formation has a width of from three to four miles, and lies on the north-west side of Star Mountain, beginning near Cog Hill and extending north-easterly throughout the State. Wherever these rocks occur the soil is of exuberant fertility. The red knobs belong to this belt.

Lying parallel with this on the north-west, occurs a belt of the Knox group. This formation is characterized by cherty knobs and shaly hills, with large masses of magnesian limestone cropping out in the valleys. This series of rocks presents a larger area of good land than any other in the Ocoee and Hiwassee district. All the soils west of Athens nearly to Decatur, are based upon this formation. A few narrow strips of the Nashville and Trenton limestones occur, the principal one lying west of White Oak Mountain. The coal formation presents itself in but one place in this district, and that is on Lookout Mountain.

ECONOMICAL GEOLOGY.

Having given the principal topographical and geological features of this region, we propose now to describe, in detail, such minerals, rocks, mines, water powers, agricultural features, etc., as may have an economical value.

TELLICO PLAINS.

At this place, situated in Monroe county, on the Tellico river, thirty miles above its mouth, are some of the most noted deposits of iron ore and roofing slates in the State. The Tellico river breaks through the mountains, making a rapid descent, cutting through the Ocoee conglomerates and slates and debouching into one of the most extensive valley plains in East Tennessee. Numerous spurs radiate to the north-east, east, and south-east, and join the main Unaka range a few miles distant. The spurs are heavily clothed with a fine forest growth, consisting of chestnut oak, pine, black oak, and hickory. The gorges that lie between these numerous spurs supply an easy outlet to the timber, while the Tellico river could be utilized by flumes for conveying wood, for a considerable distance above. The most extensive deposit of iron ore now opened at this place is the Coppinger bank, lying about one and a half miles south-west of the Tellico works. The ore here is a compact brown hematite, deep black in color, resembling great blocks of coal. It is singularly free from impurities, as the analysis below, shows:

Iron Ore from Tellico.

Dark brown, cellular ore. It contains 55.25 per cent. of iron. Specific gravity 3.38. Analysis:

Combined water	10.90
Silica.....	7.59
Sesquioxide of iron.....	78.94
Oxide of manganese.....	0.93
Alumina.....	1.68
Phosphorus	0.28
Sulphur.....	0.04
Lime.....	trace
Magnesia.....	trace

Total.....100.36

N. T. LUPTON,
Prof. Chemistry, Vanderbilt University

During the war, about 100 tons were taken out and placed in a pile, ready to be roasted, preparatory to working in the furnace. This ore now has the appearance of having been coated with pitch. No oxidation is discoverable.

There are two principal varieties at this place, viz: the compact and the honey-combed. Shot ore is found at other banks, which will be described hereafter.

The excavation at the Coppinger bank is about 180 feet long and 40 feet deep, and has been made in the face of a ridge, near the foot. This ridge is quite three hundred feet above the level of the valley. The ore shows itself throughout the entire height of the excavation and reaches below an unknown depth. It lies imbedded in a matrix of yellow, white and maroon colored clays, which give a variegated appearance to the sides of the excavation. The ore is found scattered in this matrix, occurring sometimes in large blocks that would weigh many tons, and then again in nodules not larger than a walnut.

The ore shows no flint or siliceous matter in its composition, and it is mined with great ease and rapidity, one hand being able to raise three or four tons per day. The stripping usually consists of a thin layer of clay, not more than two or three feet in thickness, and of the quantity of material taken from the bank, fully one-half is ore.

It is believed, owing to the manganese contained in this ore, that it will prove invaluable for the making of Bessemer steel. However this may be, it is known to make a very superior iron, being tough, hard, and of great tensile strength. Much of it was wrought into ornamental work, such as settees and iron railings, which proved very durable and strong. The Confederate government, owing to the superior qualities of this metal, had made every preparation to establish an armory at this point, but the accidents of war prevented its accomplishment. Car wheels made of this iron in 1851, 2 and 3, are still in use on the Memphis

and Charleston Railroad, and are still good and serviceable. Since the furnace at this place was in blast, a new bank has been opened between the Coppinger bank and the furnace, on the north-west side of the same ridge which contains the Coppinger bank, and midway between that and the furnace. The ore is of the same quality as that found at the Coppinger bank, and appears in inexhaustible quantity.

The Donnelly Bank lies three miles south of the old works, high upon the mountain side, and shows an abundance of ore largely intermixed with ocherous earth. The ore is not so compact as at the Coppinger bank and is much more inconvenient to reach. It is mainly fine or shot ore, and outcroppings of it are found for half a mile or more upon the sides of the mountain. While it might be desirable to hold this bank in reserve, we do not doubt that the Coppinger bank will supply ore enough to last for centuries. From all the indications it would appear that the ore at the Coppinger bank ranges in thickness from seventy-five to one hundred feet, and extends on the side of the mountain six hundred yards or more. A tramway or railroad, built from the Coppinger bank to the site of the old furnace, would no where have a grade of over fifteen feet to the mile.

Below the furnace, on the opposite side of Tellico river, occurs a fine bluff of limestone, which can be quarried and brought to the furnace at a very small cost. Good sandstone for hearths is also found near the furnace site.

Opposite the old furnace is a bluff of roofing slate of very superior quality. Nearly every color is here found, violet, green, brown and blue. The slate lies in belts alternating at distances of sixty or eighty feet with conglomerate sandstone. The strata are very much disturbed, numerous faults occurring in the formation, so that the slate appears, dipping at all angles, from nearly horizontal to perpendicular. The quantity of this material is inexhaustible, extending in the ridge fully three fourths of a mile. Its quality is

unsurpassed. It splits easily and has so much toughness that it may be pierced with holes almost as close together as a piece of tin. Struck with a hammer, a round role may be formed without shivering the slate. It contains no pyrite and is impervious to water. Specimens that have been lying exposed from time immemorial, show no sign of decay. It is also a good fire-resister, having been used in the construction of a blast furnace. As is the case with all real slates, it splits perpendicular, or at some angle, to the plane of stratification. Several years since this property was leased for the purpose of being worked, but the want of transportation put a stop to the enterprise.

Copper Ore.—The large veins of milky quartz that form quite a prominent feature in the high rounded hills east and south-east of Tellico Iron Works, have excited delusive hopes as to gold, and many parties have, from time to time, prospected this region for the precious metals. Though doomed to disappointment, so far as gold is concerned, a bed of copper ore has been discovered five and a half miles south-east of Tellico Plains, on the waters of Crawfish creek, a small tributary of the Tellico, which enters from the left of the stream. This bed of quartz and copper glance appears at the foot of a water-fall some fifty feet high. The principal bed crosses the stream at right angles and shows an exposed surface of about four feet. It is enclosed between two layers of hard talcose slate. Two other veins appear, one four feet below and the other six above, in which the copper glance is seen, though not so abundantly as in the middle vein. The direction of the vein is north-east and south-west, and the copper glance shows itself in bunches distributed through the quartz, so as to make probably a tenth of the whole mass.

The Crawfish is a wild mountain torrent that falls several hundred feet within a mile. Just below the water-fall, where the copper vein crosses the creek, the talus, composed

of talcose slates, has accumulated in great quantity, so as to hide a portion of the vein. The vein enters the sides of mountains that rise up quite abruptly, whose slopes are densely covered with white pine, buckeye, spruce, beech, poplar, hickory, dogwood, with an undergrowth of laurel and various species of creeping vines, which hang gracefully down the bold face of the waterfall, forming a net-work of rare and exquisite beauty.

The only possible outlet for the ore from this place will be by the construction of a road to the mouth of Crawfish, two hundred yards distant, and thence down the Tellico.

The ore from this place had the reputation of containing silver to the amount of sixty dollars to the ton, which was said to have been obtained by analysis; but Prof. Lupton, of the Vanderbilt University, who accompanied me in the expedition, procured himself some of the best specimens, and after a careful analysis, failed to detect any trace of silver whatever. The following is his report:

"The specimen of so-called 'silver ore,' from near Tellico, is a sulphide of copper known as Chalcocite, copper glance, or vitreous copper. It is a mineral of dark, lead gray color, with bright metallic lustre, running in veins through white quartz. The green and bluish color imputed to the quartz, is caused by oxidation of enclosed ore.

Analysis.

Copper.....	72.25
Sulphur.....	20.80
Iron.....	0.31
Silica.....	2.97

100.28

"Disregarding the silica, which composes the gangue and is not in combination with the ore, the result of analysis may be stated as follows:

Copper.....	72.54
Sulphur.....	21.42
Iron.....	0.32

100.28

N. T. LUPTON,
Prof. Chemistry Vanderbilt University."

It is quite probable that the vein, when stripped, may show considerable width and may prove very valuable. This is the only copper that has been found in the Ocoee and Hiwassee district, outside of the high copper valley which lies in Polk county, an account of which may be found further along in this pamphlet.

Water Power.—Nowhere in the State is to be found more excellent or available water powers than that afforded by the Tellico river, at the point where it breaks from the mountains. The river rushes down into the valley through high bluffs of slate and conglomerate rocks. Numerous tributaries pour into the main stream just above the old furnace. From the mouth of Wild Cat creek, one and a half mile above the furnace, the river begins to descend rapidly, falling 11.45 feet within a distance of 457 feet. At this point the stream is eighty feet wide, with an average depth of eleven inches. From this point down to the second fall, a distance of 3561 feet, the stream passes over a smooth slate bottom, and will average seventy-five feet in width, falling within that distance twenty-five feet. Then it makes a second rapid descent for the distance of 1753 feet above the old furnace, and falls within that space 17.53 feet. The banks of the stream are composed of bluffs of slate and conglomerate, with veins of quartz. These bluffs rise to the height of three or four hundred feet, yet level land enough lies upon the margin of the stream for the erection of buildings and for the construction of a flume or race.

At the foot of the falls the country widens out into an extended plain, covering fifteen or twenty square miles. For the production of all the cereals no land in the State surpasses that of the Tellico Plains. Records show that forty bushels of wheat and over a hundred bushels of corn per acre have been gathered from the bottoms lying west of the old furnace. Far in the distance westward, hills and mountains raise their crests high above the valley, giving a

picturesque beauty to all the surroundings. Abundant supplies for a dozen furnaces could be drawn from the productive valleys which run down towards the Hiwassee. The erection of furnaces here would produce a home market that would add immensely to the profits of the agricultural community. The rich grasses that cover the lofty spurs which run down from the east to Tellico Plains, would subsist, for nine months in the year, great herds of cattle, and the abundant mast could be utilized in the raising of swine.

There is but one drawback to this region, one of the fairest in this or any other State, and this is a want of transportation. During the high tides in Tellico river, grain and iron products may be freighted out to the Little Tennessee, but the season for such boating is very short and very uncertain. A railroad constructed to run from Tellico to the head of navigation on the Hiwassee River, near Cog Hill, would have a south-western direction along the foot of Star Mountain, through the Conesauga valley, one of the most productive in East Tennessee, and would open up this whole region to capital, skill and enterprise. A preliminary survey of such a road has been made by Civil Engineer T. D. Johns, and the grade at no point exceeds fifteen feet to the mile. His estimate is that the cost of a narrow guage railway along this route will not exceed \$4,000 per mile for grading and ties. All along the line the farmers are anxious to contribute for the construction of such a road, and it is thought that one half of the amount necessary could be raised by private subscription.

In addition to the iron ore and slate found at Tellico Plains, which would give constant employment to a considerable number of cars, there are other deposits of brown hematite on the line, where charcoal furnaces might be erected in positions quite favorable for cheap working, as at Tellico.

Star Mountain, which extends in a north-easterly direc-

tion from the Ocoee river for about thirty miles, is, as before stated, in the Chilhowee range. It rises about 1,200 feet above the Conesauga valley, and is made up of limestones and Chilhowee sandstones., the former extending about two-thirds of the way to the top.

White Cliff Springs are situated on the extreme north-eastern point of this mountain, and is quite 2,500 feet above the level of the sea, the highest improved watering place in the State. Here chalybeate, alum, freestone and sulphur waters burst out from a little spoon-like cove in its north-eastern extremity. All the conditions of a sanitarium are here found—elevation, pure air, healthful waters, magnificent scenery, and a sky singularly brilliant. The locality is above the dew point and the atmosphere is dry, bracing and highly exhilarating, acting as a tonic upon debilitated persons. The scenery from White Cliff Springs is grand and imposing. In the valley to the north-west the singular line of red rounded knobs appear stretching away to the north-east, while running alongside, at intervals of a mile or two, the beautiful ridges rise up and pursue their continuity until they fade away in the hazy distance. Standing upon the north-eastern edge of Star Mountain, Ground Hog and Chilhowee Mountain proper stand out clearly defined against the sky. Looking to the south-east, the bold Unakas, in all their aged magnificence, appear in tinted beauty. Across the valley and far beyond them, just discernible in their misty gauze, are the high points of the Black Mountains, that rear their crests nearly 7,000 feet above the sea, the highest elevations found east of the Rocky Mountains. Mount Mitchell, Mount Clingman, Black Mountain, and other isolated peaks lift their rounded domes in the interspace between the Unakas and the Blue Ridge, and form an attractive and imposing feature in the landscape.

The buildings at White Cliff are extensive and convenient. The approach up the mountain is by two roads which wind

in many devious ways up the mountain sides, where the timber sometimes gives place to open patches, when the unequalled view bursts upon the visitor in all its sublime and picturesque beauty. The thermometer marks at White Cliff a temperature from ten to twelve degrees cooler than at Nashville. In 1875, the highest temperature reached in August was 78°, which was at 4 o'clock on the 31st. Observations for 1876 show no higher temperature than eighty degrees, though at Nashville it rose to the blistering height of 99°. No pleasanter summer resort can be found anywhere, though there are many other points in the State which would afford equal attractions, if improved.

All along the north-western face of Star Mountain, just below the Springs, brown hematite lies scattered over the surface in considerable masses. Skirting the north-western base of the mountain, blocks of ore lie intermixed with great sandstone boulders that have rolled down the mountain side. Four miles below, at Hurt's farm, the ore appears on a terrace 250 feet above the Conesauga valley, on the side of the mountain, in sufficient quantity to run a furnace. One mile lower down, opposite Cooper's, it crops out in large masses, and also still lower down the valley, at Foster's and Wells'. But its greatest development is at Gee's Creek, six miles below. Gee's Creek is a confluent of the Hiwassee, and takes its rise from numerous springs upon the sides of the mountain. It cuts a deep gash in the face of the mountain at its point of exit, which gash higher up has numerous ramifications, spreading out on the face of the mountain like the limbs of a pictured tree. The general course of this stream is south-west, and at the point where it leaves the mountain, the sloping hills are from 250 to 300 feet high. On these hills occur the largest deposits of brown hematite that I have anywhere examined. It crops out in blocks, one of which is 175 feet long, with a face of fifteen feet. Tracing the deposit upwards, it appears for more

than one mile and a half. Its thickness can not be less than 125 feet in a perpendicular line. At its highest point of outcrop, a trench fifty feet long has been dug upon the side of one of the numerous radiating spurs, which displays the solid ore at least forty feet thick, with not more than two or three feet stripping. At the head of this trench a block fifteen feet long and six feet high sticks out of the side of the spur, and this is but one specimen of the many which may be found here, covering in the aggregate several square miles. Sixty feet above the point where the last-mentioned block of ore juts out, and nearly on the top of the mountain, masses of shattered ore of fine quality are found. Indeed, from near the foot of the mountain to the top, one would be justified, in speaking of the place, to call it an iron mountain, so great is the quantity. As to quality, it resembles all the brown hematites found in this region, being very black and massive, and hard to break. Some few ocherous specimens are met with. The analysis of the ore, as made by Prof. Lupton, is given below :

"Limonite from Gee's Creek. Dark-brown, cellular ore. It contains 61.92 per cent. of pure iron. Specific gravity 3.32.

Combined water	10.81
Silica.....	.83
Sesqui-oxide of iron.....	88.47
Sulphur.....	.09
Phosphoric acid.....	trace.
Lime.....	trace.
Magnesia	trace.

Total.....100.20

N. T. LUPTON,

Prof. Chemistry, Vanderbilt University."

This region is very rough and mountainous, as already intimated, cut up into innumerable ravines and finger-like spurs, whose sides and tops are thickly wooded with a fine growth of yellow pine, red oak, chestnut and black jack. Upon the crests of the ridges shivered masses of sandstone and gravel are found. The soil is there poor and unpro-

ductive for field crops. A few coves on the mountain top produce moderate yields of corn and oats. Lying at the foot of the mountain, however, are rich valleys, where corn, oats, sorghum, hay, potatoes, and other products grow in profusion. The Conesauga valley, lying at the northwestern foot of the mountain, will average a mile in width, and has a generous limestone soil, while the bottoms on the Hiwassee, at the mouth of Gee's Creek, are unexcelled by any in productive capacity and durability.

Gee's Creek enters Hiwassee just at the head of navigation, near the Savannah Ford. Steamboats can run to this point for eight months in the year, and by deepening the water to three feet, which could be done by the construction of dams at a cost of \$25,000 or less, an outlet could be given to one of the most extensive deposits of iron ore, if not the most extensive in the State, as well as cheap transportation to the corn and wheat that are grown so abundantly along its banks. It is estimated that 50,000 bushels of wheat and 300,000 bushels of corn annually would thus find a way to market.

The Narrows of the Hiwassee occur half a mile above the mouth of Gee's Creek. At this point the river breaks through the mountain by a deep canyon-like gorge, and descends with great rapidity. Its width at the Narrows is compressed within the space of 98 feet, and the water rushes rapidly through this narrow pass, falling within the distance of 5,610 feet, 22.39 feet, or about twenty feet to the mile. The Narrows begin about one-fourth of a mile below Spring Creek, which rises upon Star Mountain in Monroe county, and has itself a sufficient volume of water and a sufficient fall for driving any manufacturing establishment.

The average depth of water at the Narrows of the Hiwassee, as measured by T. D. Johns, Civil Engineer, is two feet 4 inches, with a mean velocity of $3\frac{1}{2}$ miles an hour.

Throughout the extent of the Narrows the river will average in width 136 feet; the narrowest point being 98 feet and the widest 186 feet. On both sides of the river there is between the banks of the stream and the foot of the mountain escarpment, a gently sloping strip forty to fifty feet wide, along which good wagon roads have been constructed. These strips furnish good building sites for manufacturing establishments or furnaces, as high up as the mouth of Spring Creek, and even beyond. The strip on the north-western side widens out near the mouth of Spring Creek into a broad and comparatively level area, covering fifteen or twenty acres, which has just sufficient slope for the easy construction of stock yards for furnaces. To this point the ore from the high points on Gee's Creek can be brought down by chutes. Should it be deemed necessary, furnaces could be located both upon the Narrows of the Hiwassee and upon Spring Creek. The water of the latter stream has an average depth of ten inches and an average width of 46 feet, with a mean velocity of four and a half miles an hour. The supply of water from both the Hiwassee and Spring Creek is very constant. Great floods sometimes occur, but the river never rises above the narrow strips that lie on each side.

A noticeable fact is observed of the streams heading in the north-western side of the Chilhowee and Unaka mountains, and that is, their constant flow. This is no doubt due to two causes: 1st. The deep gorges protect the water from the sun, thereby lessening the amount of evaporation; and, 2d. The streams run for the most part over argillaceous shales, which are less absorptive than the rocks on the opposite sides. This is quite an important fact bearing upon the future of this region, which in time must become one of the principal points in the State for the production of charcoal iron. These streams are numerous and penetrate in every direction the very heart of the timbered mountain districts. In other localities one of the heaviest

items of expenditure connected with the production of iron, is the construction of roads and the carting of wood to the coaling grounds, and from thence to the furnaces. Throughout this region, where these streams occur, flumes may be constructed at a cost far less than the cart or wagon roads in a mountainous country. Into these flumes the water may be turned and wood floated to the coaling grounds below, without any other cost than the attention of one man to feed it into the flumes.

These flumes are cheaply and easily constructed. Where the streams have but little fall, one or two logs flattened are put down so as to dam back the water, thus forming a pool. The wood is thrown from the slopes of the hills above into the pool. From the pool a flume is constructed to the coaling ground below, by nailing two boards or planks together, forming a triangular trough like a Yankee hog trough. This is fastened in the dam by cutting a triangular notch in the top log, the trough being let down until its top surface coincides with the top of the dam. The water is shut off by a small flood gate. The flume should be as nearly straight as possible—all abrupt angles being avoided, as they would be liable to obstruct the wood in its descent. The grade should be regular, as the flow of the water will then be uniform and constant. One man with a spike pole aided by the gentle current of the water in the pool, will keep the wood flowing in a constant stream without further cost, whether the flume be one mile or ten miles long. This system of transporting wood has never been practiced in our State, but its complete success in Colorado and other places where mountain streams abound, suggests its practicability in the Tellico and Chilhowee iron districts, where the mountain spurs are high and steep, and where the streams are numerous. By the aid of such agencies, the wood of the vast forests that abound in the mountainous districts could be cheaply utilized.

The material for the construction of these furnaces at Gee's creek is very abundant. The Chilhowee sandstones lie in beds of suitable thickness for quarrying. Some of the strata are soft and easily worked, but the stone is exceedingly durable in fire. Limestone in suitable thickness also occurs in the valley below.

Nor is the iron ore confined to the northeastern side of the Hiwassee river, but continues down Star Mountain in a direct line to the Ocoee river, and even beyond, appearing on the side of Round Top Mountain, and on the waters of Sittico Creek and other tributaries of the Ocoee flowing from the west. Three miles southeast of Benton, many years since, a shaft was sunk to the depth of forty feet in the side of Star Mountain in search of copper, which revealed a fine ochereous and compact brown hematite. This shaft was sunk near the edge of a ravine which makes a gash in the mountain side. The declivity is very gentle, and a tramway could be constructed to Hiwassee river, of easy grade. The slope below the ore is thickly but not heavily timbered, with black jack and hickory, while upon the sides of the mountain above, chestnut, chestnut-oak, pine, hickory, red oak and post oak predominate. The surface is made rough with sandstones that have tumbled down from above.

The ore is associated with a ferruginous shale and soft crumbly sandstone, with a yellowish clay. The whole extent of the ore as traced from Tellico to a point beyond Round Top Mountain is quite thirty miles, and there is scarcely a break in it, except a short space occurring between Tellico Plains and the head of Star Mountain, a distance of seven miles. This belt of ore has the general course of all the ridges of East Tennessee, that of about north 20° east.

GOLD DISTRICT.

Before closing my report of this part of the Ocoee and Hiwassee mineral district, it may be well to say a few words

in reference to the gold bearing district, which lies mainly in Monroe county, though gold has been found in Blount and McMinn counties. The gold occurs in the quartz of the Ocoee group, but nearly all the gold mined has been obtained from the gravel and sand that form the banks of the streams occurring in the regions of the veins. The gold has been liberated from the crumbling quartz. The waters of Cittico creek, Cane creek, Coco creek and Tellico river, all take their rise in the gold region. Most all the gold product has been obtained on Coco creek. The region is a depression or wide flat trough, cut deeply by streams, lying between the Chilhowee range and the Unakas on the south-east. The width of the belt is from four to five miles, and it extends fifteen or twenty miles in a northeasterly and southwesterly direction.

Placer mining was extensively carried on many years ago in the immense gravel beds, along the narrow bottoms of Coco creek, for the distance of six or eight miles. Old citizens who lived in the vicinity, while active operations were going on, report the yield per day for each hand, to range from one to five pennyweights. Only such spots as escaped the vigilant search of the first gold hunters are now worked. One old citizen was found at work with the primitive rocker, who appeared entirely satisfied with the result, and repelled the idea of exchanging his trustworthy rocker for sluice boxes. Doubtless there are many places in the gold bearing district, which, with improved methods, could be made to pay. There is one principal gold bearing quartz vein running through the district. This was prospected at a point four miles west of Tellico river, by sinking a shaft and running a tunnel. The quartz is very hard and of a milky-white hue. The vein is about three feet in thickness. From the shaft and tunnel many beautiful specimens were taken, showing free gold. Gold has been worked out of the sands as far down as the Tellico Iron Works. The entire region will probably cover one hundred square miles.

RED IRON ORES.

Taking a belt of country lying between the red hills and the railroads, we find it rich in the red hematites. They occur on this belt in the Lower Silurian formation, and embrace both the fossil and compact ores. Three miles south of Sweetwater, in Loudon county, on the northwestern slope of the red hills, are found pockets of very rich compact red hematites of great beauty and purity. Some of this ore is rhombohedral, the result probably of fracture and not of crystallization.

It is found in nodules, varying in thickness from one inch to a foot, but is scarce and irregular in its deposits. Its extent and quantity can only be determined by a more thorough prospecting. If found in sufficient quantity it would prove valuable for purposes of "fix" for puddling furnaces, as well as for mixing with the brown hematites of Tellico Plains and Star Mountain.

Another deposit known as Thomas' bank, found eight miles southeast of Athens, in McMinn county, is remarkable for its extent and position. Unlike the last mentioned, ore, it contains flattened oolitic grains and crinoidal buttons, though not in such abundance as in the Dyestone of the Upper Silurian. The ore forms a long rounded ridge, running northeast and southwest for one and a half or two miles, with an average height of seventy-five feet above the valley. The ore extends over a width of 450 feet though the real width of the seam is about 75 feet. The strata dips here about 20° to the southeast, and the ore lies between a bed of yellowish slate, belonging to the Trenton and Nashville period, and variegated marble below. The following is an approximate section at this point:

Iron Limestone, with intercalated shales.....	250 feet.
Yellowish Calcareous Shale, (Nashville and Trenton).....	300 feet.
Fossil Ore, (hematite).....	75 feet.
Variegated Marble and Lithographic Stone.....	175 feet.
Blue Limestone, (Maclurea).....	200 feet.
Knox Dolomite.....	unknown.

The amount of ore at this place is immense. Southeast of the banks, the line of red knobs appear, the same that begin near Strawberry Plains, passing to the southeast of Knoxville, continuing southwestwardly and reaching a point a few miles east of Cleveland, where they cease to form a prominent feature in the landscape. These red knobs abound in excellent timber, and they rise up with such an even slope, that the wood could easily be brought to the valley below by chutes.

The ore found in Thomas' bank has not been worked for many years. Its good qualities may be inferred from the analysis given below, as well as from the fact that it was worked into bar iron in Catalan forges, thirty years ago, of such strength, that its excellent qualities still form a subject of conversation among the older citizens. In the banks the ore is regularly stratified, occurring in the tile-shaped, angular, flat masses, varying in thickness from a few inches to a foot. The layers are separated from one another by thin strata of deep maroon colored clay. The following is an analysis :

McMinn Ore, (Thomas' Bank.)

Water.....	7.85
Silica....	9.67
Iron.....	56.65
Combined Oxygen.....	24.27
Sulphur.....	0.09
Phosphorus.....	0.52

Important deposits of good fossil ore occur in McMinn county, besides that of Thomas' bank. These are found in the Upper Silurian in seams of varying thickness. The ore is excellent in quality and abundant in quantity. Most of the seams occur in Eastanallee Ridge, which runs nearly through the center of the county in a northeast and southwest direction. This ridge has an elevation of quite 350 feet, and is densely clothed with timber. The soil is fertile, the slopes steep, and limestone prevails throughout its entire length.

The ore lies in two or three seams near the crest of this ridge. On the lands of W. B. McKamey, five miles south of Riceville, several openings have been made, which display a seam eighteen inches thick. This seam lies between two strata of blue limestone of the Upper Silurian. Immediately above the limestone is a layer of red clay three feet thick, then a yellow shale which is capped by a dark sandy shale. The strata here all dip to the southeast, making an angle of 10° with the plane of the horizon. The openings are near the top, and the iron ore appears at a lower level on the southeastern face of the ridge. The lower outcrops show an ore highly calcareous. Specimens taken from the higher outcrop on McKamey's land, analyze as follows:

Fossil Ore, (McKamey's Bank.)

Water.....	1.02
Silica.....	13.82
Iron.....	60.21
Combined Oxygen.....	25.80
Sulphur.....	0.09
Phosphorus.....	0.72

Easterly a few miles from McKamey's, the ridge separates into two arms. A ligament on the lands of L. B. Dodson, Esq., unites the two arms. On this cross-ridge or ligament, the ore outcrops in large masses, at a much lower level than on McKamey's land, and shows a considerable amount of carbonate of lime in its composition. It is regularly stratified, however, and the line of strike is nearly northeast and southwest, with a dip to the southeast. The outcrop shows a thickness of nearly five feet, but this ore is of no great value, except as a flux, owing to the predominance of the carbonate of lime. About half-way this cross-ridge there occurs an anticlinal axis, the Dyestone ore appearing just below a yellowish shale, within fifty feet of the top. On the southwest side of the main Eastanallee Ridge, there are said to be three distinct strata of the fossil ore, but I could only find two; the upper one being from 11 to 18 inches thick, the lower one about the same. Upon the

crest of a high hill, some twenty feet above the upper seam, is a considerable outcrop of excellent ore. Large blocks lie scattered about the field, which are probably the remnant of a third stratum which has been carried away by erosion.

On the lands of Mr. Dodson, there is a spur running northwest from the main ridge, and nearly opposite the cross-ridge spoken of. Upon the western face of this spur, fossil ore appears in workable quantities, imbedded in a matrix of black siliceous earth and yellowish clay. The ore from this place is very beautiful, having a rich royal purple lustre. It occurs in square and angular blocks, in all sizes, up to that of a flour barrel. Fossils abound in it, such as crinoidal buttons, fragments of trilobites and small corals. It is very pure and is universally admired. An analysis gives the following :

Fossil Ore, (Dodson's Land.)	
Water.....	1.32
Silica.....	13.14
Iron.....	60.03
Combined Oxygen..	25.72
Sulphur.....	0.024
Phosphorus.....	0.13

In another ridge lying between the two arms, but farther to the northeast, a great mass of fossil ore appears on the side of the ridge, which will weigh many tons. It is four or five feet across, and lies in a bed of rocks that shows great disturbance. This ore is very hard, and judging from its appearance it is also very rich. Above there is a stratum of limestone deeply tinted with red. This outcrop is on the lands of Hon. N. Dodson. Northeast of this place outcrops of fossil ore are numerous in Eastanallee Ridge and its spurs and outliers. Several of these, belonging to J. L. Carruth, are promising. One average sample analyzes as follows :

Ore from Eastanallee Ridge.	
Water.....	1.10
Silica.....	18.05
Iron.....	56.58
Combined Oxygen.....	24.24
Sulphur.....	0.04
Phosphorus.....	0.63

Two seams appear all along Eastanallee Ridge for many miles. The timber on the ridges is of very superior character, while the soils are among the best in the State, and highly productive of the bread-grains. Water power is furnished by the numerous parallel streams which empty into the Hiwassee river, and railroad communication by the East Tennessee, Virginia and Georgia Railroad.

Several small deposits of brown hematite occur on the hills near Riceville, but they are of no particular value, owing to their proximity to other and better iron ores.

Near Thomas' bank some quarries of lithographic stone have been opened. In the present state of the lithographic and chromo-lithographic arts, the fine-grained and exceedingly rare stone, suitable for these purposes, is of great importance. The lithographic stone of Bavaria was awarded a premium at Paris in 1865, and that of Solenhofen, Bavaria, is largely imported by the United States. Large deposits of this valuable stone are found in McMinn county, Tennessee, which are said to equal the Bavarian. If this be true, it will prove of inestimable value. It lies between two beds of variegated marble. The stratum is thought to run entirely through the county, but some of the stone is too hard for lithographic purposes. The best is found eight miles east of Athens, on the farm of Robert Cochrane, and a quarry has been opened by a Cincinnati company, which only pays a royalty of \$250 per annum. It is sold for nearly the same price as the Bavarian stone. It is a calcareous and argillaceous stone, formed of the finest sediment, of uniform texture, and possesses a pearl grey tint. The best variety of this stone has a conchoidal fracture, and is free from spots of all kinds.

Lead Ore.—Lead occurs three miles south of Riceville, and at the present time (July, 1876,) quite a number of miners are at work, with a view of determining the extent and value of the deposit. The lead is disseminated in bunches or nests

through the Trenton limestones. There are several ledges in which it is found embedded, and silver is reputed to exist in some of the specimens. The samples, however, which I procured, showed no trace of the precious metal. The lead occurs near the point where the Knox Dolomite forms the surface rock, and it is quite probable that the deposit exists in both formations.

Hambright's lead mine in Bradley county, has furnished a considerable amount of ore. It was extensively worked during the late war, but afterwards abandoned. At present, the water is being drained from the old shaft and entries, for the purpose of making additional examinations. A vein of twenty inches thick is reputed to exist, but for the truth of this statement I cannot vouch.

Associated with the lead ore is baryta. Many heavy deposits of this mineral are found on the hills near the Hiwassee river. Four miles below Calhoun, on the point of a hill, one-half mile below the mouth of Mouse creek, on the east side of the river, in McMinn county, a bed of baryta forty feet thick has been found. Some of it is very white, and it will doubtless, some day form an extensive article of export.

The lands in the lead and iron regions of McMinn county, are among the most valuable in the State. Heavily timbered, especially on the ridges, with long level stretches of bottoms, lying on the many small streams which flow down and form the Eastanallee, the principal artery of the valley, they produce extraordinary yields of corn, wheat, oats and hay. Some of the coves have a dark red, coarse, sandy soil, exceedingly fertile, and forming the best clover lands in the State. Here, in a good season, it is not uncommon to find clover growing six feet long, and covering the ground with a mat so thick, as to be unmanageable with the ordinary two-horse plow. Forty bushels of wheat per acre have been grown by the best farmers. As a stock-growing region, it is unsurpassed by any lands in East Ten-

nessee. The Conesauga, Chestua and Eastanallee, all confluents of the Hiwassee, are famous for the excellence of their bottom lands, and in no place in the State is the toil of the husbandman better rewarded.

Several manufacturing establishments have sprung up in McMinn county. Eureka Cotton Factory, situated on Chestua creek, employs about twenty operatives. It has 528 spindles, and makes cotton yarns exclusively. Mount Verd, another cotton factory, three miles from Athens, on Mouse creek, employs about thirty operatives, and has 924 spindles. About 300,000 dozen of cotton yarns are made annually at this place. Six cotton gins, two carding machines, thirty-nine grist mills, and two planing mills are in the county, all propelled by water power.

Among the many thrifty places that have sprung up through the intelligence and industry of the citizens of the county may be mentioned as an example, Cog Hill, 13 miles south of Athens. This place is on Conesauga creek, near the head of navigation of the Hiwassee. Here, within the past six years, have been built a flouring mill with a capacity of fifty barrels per day, a carding machine with a capacity of 300 pounds per day, a cotton gin, and a saw mill which furnishes a large section of country with lumber. The Conesauga, at this point, is narrow but deep, with steep banks. The dam constructed gives a head of ten feet of water, which supplies a power of fifty-horse throughout the year. The amount of wool grown in the county is about 60,000 pounds per annum, of which, 15,000 pounds are annually made into rolls at Cog Hill.

Lumber is cheap. Ten dollars per thousand is the price for inch lumber, the run of the mill; \$12.50 for choice, and \$15 for slats. Walnut brings at the mill, \$25 per thousand; cherry, \$20.

Nothing, probably, shows the stimulating effects of manufacturing establishments, more than the gratifying results

obtained at this place. Before the erection of the cotton gin, there was scarcely a pound of cotton raised around Cog Hill. Now, 75,000 pounds are ginned annually, and the production is on the increase. As one of the effects of the saw mill, a furniture manufactory is now building, and many more industries will doubtless follow.

The production of wheat is greatly increased, and tobacco will be largely cultivated hereafter. Several commercial establishments have been established, and altogether, it is one of the thriftiest little places in the State. In 1864, it was occupied by Sherman, and at the close of the war the fences on the farms were gone, the fields a net-work of gullies, and the land almost entirely exhausted. Yet with all these disadvantages, under the inspiring influence of Mr. J. A. Turley and A. H. Lusk, and other progressive citizens, the gullies have disappeared from the surrounding farms, the zigzagged fences have been replaced by long lines of post and plank, and the land has quadrupled in its productive capacity. This has been done by sowing peas and clover, and by the use of the sub-soiler. A fresh life is infused into the whole neighborhood. Schools and churches have been erected. Cane Creek Academy, near the place, ranks among the best in East Tennessee. The buildings about the place are of modern architecture, neat and comfortable, and there are such evidences of industry, that no better example can be given of what may be done at a thousand places in East Tennessee, with like energy and systematized effort. Hard times are unknown in such places, because every one from the toddling boy to the gray-haired sire, can find suitable employment at the various manufacturing establishments. Ease, comfort and plenty, with cheerfulness, intelligence, and a lively faith in the future, characterize the entire neighborhood.

No county in the State is blessed with more of the elements of a high civilization than McMinn. Its ores, its

streams, its timber, the fecundity of its soil, the intelligence of its population, its facilities for transportation, its healthfulness, its numerous schools of learning, and the high tone of its press, all foreshadow the time when the county will be famed throughout the South for its enterprising industry and accumulated wealth.

Turning now our course to the southwest, we pass numerous cherty ridges, and along fertile valleys, until we reach a most interesting mineral section at

WHITE OAK MOUNTAIN.

White Oak Mountain lies in the southern part of the Valley of East Tennessee, in James and Bradley counties, about fifteen miles east of Chattanooga. Its northern point is five or six miles south of Hiwassee river, and extends to the Georgia line, some twenty miles distant, where it takes the name of Taylor's Ridge. Its highest points are about 400 feet above the valleys. The western edge is continuous, with no spurs, but the eastern side is scalloped by deep coves, and by a succession of spurs which make out at right angles from the main ridge, like the teeth of a saw. Lying parallel with the main mountain, on the eastern side, and a quarter of a mile from the eastern points of the projecting spurs is another ridge, which I have named Hinch's Ridge. This is not so high by 150 feet as the White Oak Mountain proper. Hinch's Ridge extends north from the railroad six or seven miles, and is finally united by a ligament with White Oak Mountain. The valley, half a mile wide, lying between the two, furnishes some productive areas. Hinch's Ridge is deflected to the left near the railroad by Grindstone Mountain, an egg-shaped outlier that rises boldly up and extends southward for two miles.

The Nashville and Lebanon limestones girt the base of White Oak Mountain, and the sub-carboniferous the eastern edge. The Mountain is made up mainly of a series of shales

and sandstones, the latter being mostly fine grained, thick and thin bedded, reddish brown, with reddish and pale green shales. Overlying these sandstones and shales, is the Dyestone group, composed of red and greenish shales, with thin beds of sandstones and fossil red hematite.

Above the Dyestone group are the Black Shale and the Siliceous Group of the Lower Carboniferous. The Dyestone group and the sandstones and shales belong to the Niagara of the Upper Silurian. The thickness of all the formations indicated in the mountain is about one thousand feet. Of these the transition beds resting upon the Nashville rocks is about 300 feet; White Oak Mountain Sandstone, 400 feet; Dyestone group, 200 feet; Black Shale, 20 feet; Siliceous group, 80 feet. The strata dip at an angle of about 30° and the measurements were sometimes difficult, owing to the variation in dip. The thickness of the strata is much greater than the height of the mountain.

Beginning with Hinch's Ridge, four miles northeast of Ooltewah, the county seat of James, and which, as before mentioned, is an outlier of White Oak Mountain on the east, we find extensive deposits of Dyestone ore on its western face. The rocks of this ridge are the same as those of the White Oak Mountain and Dyestone formations. Several seams of Dyestone make in part the layers of the synclinal trough which forms the northwestern face of Hinch's Ridge. (See map.)

Excavations have been made on the face of the ridge facing White Oak Mountain, where the following section was taken, beginning with the lowest and ascending. It may be remarked that the lowest strata outcrop the highest on the side of the ridge.

White Oak Mountain Sandstone.....	Unknown.
Soft gray sandy shale.....	1 ft. 9 in.
Dyestone ore, dark purple.....	1 ft.
Soft brown shale.....	1 ft. 4 in.
Dyestone ore, dark red.....	1 ft. 3 in.

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Gray sandstone and shale.....	3 ft.
Ore, Dyestone.....	1 ft. 1 in.
Greenish, soft picking shale.....	2 ft. 2 in.
Ore, Dyestone.....	2 in.
Gray and green hard shale.....	1 ft. 6 in.
Ore, Dyestone.....	2 in.
Blue calcareous shale, very hard.....	1 ft. 2 in.
Ore, Dyestone.....	1 in.
Shale and sandstone.....	18 ft.
Ore.....	11 in.
Greenish calcareous shales.....	Undetermined.

The synclinal trough is not more than 300 feet across, and two or more wrinkles are found in going westward across the valley that lies between the ridge and White Oak Mountain.

The ore at the bank where the section was taken has been worked for two years. The excavations have been carried from the valley upward for 150 feet. The average amount mined is two tons per day for each man. After the bank has been well opened, it is thought double that amount can be raised without difficulty. The hard, blue, calcareous shale, with which the ore is interstratified, cannot be worked with a pick, but must be separated by blasting powder. The ore is often found adhering by a well defined line, to the calcareous shale, and not easily separable.

From this mine a tramway has been constructed to a point lower down the valley, and from thence the ore is hauled by wagons to the East Tennessee, Virginia & Georgia Railroad. The price paid at present for raising ore is 30 cents per ton, and it is sold, delivered on the cars, at \$1.25 per ton. The cost of shipping to Chattanooga is 75 cents per ton, making the ore delivered at Chattanooga cost \$2.00 per ton.

At the distance of 400 yards south of this bank, and across a little ravine that makes a notch in the western side of the ridge, several openings have been made, which give a good display to the ore. In these the strata dip at a

higher angle than in the openings first mentioned. On the crest of the ridge the seam is almost perpendicular, deflecting however, more and more to the west as the excavations are deepened, until it turns and dips in the opposite direction. The ore at the outcrop on the crest of the hill is very hard and fossiliferous, abounding in casts of crinoidal buttons, fragments of coral, trilobites, bryozoa and oolitic bodies. At this place the seam is ten inches thick. The outcrops of several other seams appear on the ridge, but only one has been worked.

Near the crest of this ridge is a series of sandstones, some of which are beautifully laminated with smooth surfaces, suitable for flagstones. Many of these sandstones make good whetstones, others are hard and difficult to work.

North of the first bank described, are two other openings, where the ore does not differ in position or quality. The seams are often warped, making changes in the angle of dip of several degrees.

In the basin of Wolf Cleaver creek, which runs down the valley between Hinch's Ridge and White Oak Mountain, the wrinkles or folds are easily traced. The bed of the creek shows a second synclinal, making the distance from the bottom of the synclinal, where the ore has been mined, to the bottom of the one in the creek about 300 feet. The bed of the stream is filled with blocks of Dye-stone ore, and seams of it are found outcropping in the eroded banks.

It may here be mentioned, that the ore is always purest where it is highest above water level. It becomes in the bottoms of the synclinals more calcareous, and does not separate so easily from the containing rocks.

The ridges and coves generally in the vicinity of White Oak Mountain, as well as the main mountain itself, are heavily timbered, except upon the immediate outcrops of the ore. The trees most abundant on the ridges, are poplar, oak, chestnut, pine and hickory.

One mile above the point where the Wolf Cleaver crosses the road, and two miles above the place where the section was taken, the Black Shale or Devonian formation makes its appearance near the bed of the stream, with the Siliceous group lying above. At this place one entry has been run into the shale by some persons, in the vain effort to find coal, an expenditure of money which a slight knowledge of geology would have saved. The ridges formed by the overlying crest, are much steeper than those containing the Dye-stone ore.

Three miles higher up the valley, which continually narrows, and at some points is almost cut in two by projecting spurs, the ligament mentioned as uniting Hinch's Ridge with White Oak Mountain occurs. This is called the "Dividing Ridge," and is the watershed between the head of the Wolf Cleaver and Wolf Pond Branch. The latter stream flows in a northerly direction, debouching into the Savannah Valley, and pouring its waters into the Savannah Creek three miles below, leaving White Oak Mountain on the east. Two miles above its mouth, and at a point where it passes out, by a deep defile, from White Oak Mountain, a beautiful fossil ore is found upon the lands of Alexander Mahan. It covers all the western slope of the mountain, and lies in the beds of the stream in rounded blocks. Some of it resembles specular ore, showing fine steely shining points, and contains no perceptible fossils. When broken these fine steely points are displayed in great beauty, set in a reddish, compact ground. Several ledges are said to occur on the slope of the mountain, but I was unable to find them. I traced the blocks of ore quite 500 feet up the mountain side. Half way down the mountain I found in an exposed bluff, two or three thin seams interstratified with a bluish, calcareous shale, but the largest blocks are found, 200 feet or more above this, on the bluff. The timber where the surface ore is most abundant is very

scant, consisting of a few scrubby pines and chestnuts. The outcropping rocks are mainly yellowish shale and whitish sandstones, with smooth, almost polished surfaces.

The strata here are nearly horizontal. Large, thick layers of red sandstones appear near the base of the mountain, and the timber is very fine, large poplars and oaks being abundant.

Returning to Hinch's bank from which the tramway is constructed, and crossing over the Wolf Cleaver Valley westward, we entered upon an examination of the ores of White Oak Mountain proper.

Between the ridge and the mountain, the carboniferous limestones outcrop in layers nearly horizontal. This valley extends down to the crossing of the railroad, and is shut in on the south by Grindstone Mountain, an eastern outlier of White Oak Mountain. This outlier deflects the course of Hinch's Ridge, as has been mentioned, to the east, the Grindstone Mountain being, as it were, a knob two miles long and one mile wide, running up in the expanded valley. It may be mentioned, that the ore is found for several miles further down in Hinch's Ridge.

The first outcrop of Dyestone, inspected in White Oak Mountain, is at the margin of a little branch west of Mr. Hinch's house. The reader should bear in mind that the whole eastern edge of White Oak Mountain sends out projecting spurs, a half mile or more in length, and between the spurs usually small streams of water flow down to the Wolf Cleaver, a tributary of Ooltewah creek a confluent of Tennessee river. On the little streams mentioned, the strata dip at an angle of about 15° to the southeast. Further down the branch the dip becomes greater.

The following section was taken by beginning near the head of the branch and tracing it downwards:

Cherty masses.....	60 ft.
Limestone, carboniferous.....	15 ft.
Sandy brown shales.....	50 ft.

Thin bedded, hard sandstones.....	5 ft. 2 in.
Sandy shales, dark brown.....	18 in.
Ore, Dyestone.....	1 ft. 7 in.
Hard blue sandstone.....	2 ft. 2 in.
Ore, Dyestone.....	4 in.
Thin blue sandy shales.....	2 ft. 4 in.
Ore, Dyestone.....	1½ in.
Yellow and blue thin sandy shales.....	6 in.
Blue and yellow flagstones, from 4 to 18 inches thick, some of them good whetstone grit.....	3 ft. 6 in.

From this point the strata are covered with debris of sandstones and shales, with blocks of iron ore. Crossing over the point of this spur northward, the surface of which is covered with masses of dark colored chert, we descend into another ravine half mile distant. The northeastern face of the spur is covered with blocks of brown hematite of good quality. This ore is nearly compact with some particles of embedded sparry matter, and casts of crinoidal stems. On the slope of the hill sixty feet above, blocks of brown hematite stick out from the surface, and it is quite possible that a rich ore bank might be opened here.

The ore lies embedded in a mass of chert and yellow clay. A fine outcrop of mountain limestone 61 feet thick, with veins of calcareous spar presents itself, in this second gorge. The strata here dips at an angle of 60°.

From this point passing northward over another spur, we found the Dyestone ore cropping out at the margin of a small stream which flows eastward into Wolf Cleaver creek. The seam at this place is six inches thick, and lies between gray sandstones. The ore is of first rate quality.

Returning to the bed of the stream from which the last section was taken, immediately west of the residence of Mr. Hinch, and passing over another spur on the south, to another ravine, the Dyestone seam is found outcropping on the northern slope of the second spur, dipping as the other seams in the main mountain, toward the southeast. The spurs on each side of this ravine rise to the height of 225

feet. They have rounded tops, and the seams on each side of the gorge are easily traced. In the spur lying on the north, a splendid outcrop appears on the very crest. It covers the surface for several yards, and may be seen all the way down the slopes of the ridge. The ore is of excellent appearance, free from calcareous matter, and easily broken with a hammer, but sufficiently hard to bear transportation well. Judging from the thickness of the blocks, the main seam must be from 15 to 18 inches thick, with evidences of other seams above and below. As is usual upon the outcrops of the ore, the timber is thin and scrubby. A few hundred yards, however, west, I noticed among other growths, yellow pine, chestnut, chestnut-oak, black gum, sweet gum, hickory, red oak, post oak, white oak, yellow poplar, with ash and sugar tree in depressions. Where the spurs unite with the main mountain, the timber is very heavy, and would yield 60 to 80 cords per acre. The same may be said of the slopes of the main axis. Tan-bark is procured in considerable quantities, and is one of the industries of this section. Fifty cents per acre is paid for the privilege of getting it. One dollar per cord is paid for cutting the trees and peeling and piling the bark, and \$1.75 per cord for hauling it to the railroad, making the cost of delivering it upon the cars, \$3.25 per cord. The price paid by dealers varies from \$3.00 to \$4.00 per cord. The price in Chattanooga is \$6.00. Chestnut oak furnishes the best bark, as well as the largest quantity.

The outcrop of ore was traced southwardly several miles. South of Hinch's residence one mile, the Black Shale outcrops in a valley on the farm of William Sanders. The hill rising above this outcrop of Black Shale is composed of chert, with occasional nodules of brown hematite. On the west side of the valley where the Black Shale appears, and half mile northwest of the residence of William Sanders, in James county, (all the other banks spoken of are in Brad-

ley,) a large outburst of Dyestone appears on a spur coming out eastward from the main axis of White Oak Mountain. The lead appears on the surface twenty feet wide. Its general course is westward but turns southward upon the main axis. It is quite probable that it here forms the top of an anticlinal fold. At all events, the finest exposure of ore found on the mountain is here presented. Thousands of tons could be gathered on the surface. From the crest to the valley below, the surface is rugged with great blocks of ore, many of them weighing four or five hundred pounds each. The ore is highly fossiliferous. Various openings have been made on the north and south faces of the spur, every one of which reveals ore. The ore lies in a stratum running parallel with the sides of the mountain, but two or three feet beneath the surface.

A little further westward, but lying still on the eastern face of the mountain, is the Sanders' bank, two and a half miles from Ooltewah. At this place considerable mining has been done. Here, also, the ore lies parallel with the face of the mountain, with about four feet of stripping, which consists of clay and shale. The ore at this bank is one foot one inch thick. Some 250 tons were lying piled up in the valley at the time of my visit. The amount of ore taken out has, thus far, exceeded the other material removed. One man can easily strip and mine at this bank six tons of ore per day. The overlying dirt and shale are shoveled down into the bottom of the ravine, by which the ore is exposed with a smooth surface like an inclined floor. It is easily broken up and slid down to the wagon-way below. It is estimated that the actual cost of mining here will not exceed twenty-five cents per ton. From the bank to the East Tennessee, Virginia & Georgia Railroad, half mile distant, there is an easy grade of not more than 100 feet to the mile.

On the same spur facing Grindstone Mountain, the ore

outcrops in a cornfield, and is so abundant that it has been used in the construction of a chimney, to a cabin situated in the field.

Crossing the railroad near the gap where it passes White Oak Mountain, and ascending a steep mountain spur running parallel with the main line of White Oak Mountain, and lying on the east side of it, the ore outcrops in a curving line from the valley, high up on the western side of the spur. Three seams are here presented, separated from one another by sandy shales. The upper one is nine inches thick, and overlying it are thin sandstones. The second seam, two and a half feet below, is three inches thick. Seven inches of shale intervene between this and the lowest.

A few hundred yards higher up on the mountain, the following section was taken from above, down :

Surface and shale.....	2 ft.
Ore.....	10 in.
Shale, green and yellow.....	2 ft. 5 in.
Ore.....	1 in.
Shale.....	7 in.
Ore.....	6 in.

From this it would appear that the seams are not altogether uniform in thickness. All the strata here dip to the southeast, at an angle of about 30°. Mining has been done on the surface of the mountain for the distance 711 feet. A tramway has also been constructed around the face of the mountain, by which the ore is conveyed to a chute which carries it to the cars on the railroad below.

Only three or four feet of the seam have been taken out. No extensive mining can be done here without drifting down with the dip of the seam, and then working the seams out laterally. The ore can then be pulled up by horse power or a stationary engine. The present system is "patchwork" and cannot be conducted much longer with profit. Situated so conveniently to the railroad this mine must with competent engineering skill, prove very valuable, unless the ore should prove too calcareous.

Very fine surface ore is collected on the opposite slope of this ridge, the quality being superior to that taken from the mines. Several openings have been made in these seams south of this place. Riggin's Bank, on the west side of White Oak Mountain, furnishes ore of excellent quality. Tallant's Bank lies on the east side. From this bank to the Georgia line the ore is found in the main mountain. Its abundance and the cheapness with which it can be mined, the great forests which cover, with their leafy canopy the thousand mountains, ridges, hills and valleys, supplying unlimited material for charcoal, the means of transportation offered by rail and water, all these point out this locality as a future seat for charcoal furnaces. The fertile valleys that run in long strips between the ridges, will supply ample quantities of provender and provisions to sustain a large manufacturing population. After such furnaces shall have been built, the agriculture of the valleys will be endowed with fresh vigor, the waste places will be reclaimed, herds of cattle and flocks of sheep will browse over the sunny slopes where the wild grasses grow luxuriantly and supply abundant forage, and a heightened energy will then be imparted to the whole region.

Grindstone Mountain has been spoken of. It takes its name from the existence of heavily bedded, cream colored sandstones upon its top, from which excellent grindstones are made. Some of its strata are nearly level, others dip at a very high angle.

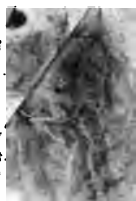
White Oak Mountain proper does not extend north of Hiwassee river, but there is a group of low ridges which begins a few miles north of the Hiwassee and extends to the Tennessee river near Kingston. This group of ridges belongs to the Dyestone formation, and displays one of the finest outcrops of ore to be found in the State. Beginning at Welcker's ridge, three miles south of Kingston, we have a most interesting section. Welcker's ridge may be

called the extreme northern terminus of the White Oak Mountain. It extends southwardly for twelve miles to Ten Mile, where it is cut by the Sewee, but afterwards resumes its course for several miles, extending in a south-west direction. Welcker's ridge, near Kingston, lies between Riley's Creek on the west and Stamp Creek on the east. It is composed, for the most part, of a trio of ridges. The western ridge is about 300 feet high and is continuous. The eastern ridge is probably 100 feet lower and is also unbroken, but the middle ridge passes backwards and forwards from the western to the eastern, running sometimes nearly parallel, and then again nearly perpendicular. At the northern end, near the river, there is a hollow running southward half a mile and separating the western ridge from the middle. The Dyestone seam is found here in the middle and eastern ridges, but does not appear on the western ridge within half a mile of the river. Beyond this it may be seen in the western ridge, lying nearly parallel with its eastern slope and cropping out on the crest and in the bed of a little stream that washes its eastern foot. Usually it is from four to six feet beneath the surface. Its thickness on the western ridge varies from three to four feet.

A large amount of surface ore occurs on the eastern slope. Thousands of tons could be collected. The slopes are well covered with timber—pine, black oak and chestnut constituting the principal trees. In the gorges cut by the streams some very large yellow poplars are seen.

The stratum of ore dips eastward in the western ridge, passes entirely under the middle range, and crops out on the very top of the eastern ridge, being in this nearly perpendicular, with a slightly western dip, making a grand synclinal, which holds in its centre the middle ridge.

The outcrop of ore in the bed of the small stream that flows between the western and middle ridges, has a part in



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of sandstone seven inches thick, one foot and nine inches of ore lying below the sandstone and three feet six inches above. That below the sandstone is singularly free from calcite, which is a rare occurrence where the ore is found below water level. The ore, both below and above the sandstone, is very hard and compact. Fossils do not appear to exist in it to the same extent as in the ores taken from other places.

In the third or most eastern ridge of the trio, the outcrop is very thick. At one place, where a branch from a chalybeate spring passes through a gap, there is an outcrop of nine feet eight inches of ore, with a parting of sandstone one foot thick. Nor is this an exceptional thickness. On the slope of the hill, thirty feet above, the ore and sandstone parting measure 10 feet 6 inches. The same outcrop continues for miles southward, and extends to the Tennessee river on the north. The ore, as it appears in the hill, is more porous and frangible than that in the bed of the creek below. It is easily mined, and is doubtless an excellent ore. A bed of sandstone 37 feet thick lies below the seam at this point, and 52 feet of shale above.

This is the best development of the Dyestone ore that I have met with in the State, though there are places in the Half Moon Island region, to be mentioned hereafter, with seams nearly as thick. Thirty thousand tons to the acre can be taken from this seam, supposing the ore to form a stratum parallel with the slope of the ridge. This large outcrop is about one mile from the Tennessee river and four miles from Kingston. The grade to the river is easy, and a tramway constructed from the ore to the river would give an easy outlet.

One mile further south an opening has been made, which shows the same thickness of ore, and another seam above of equal thickness. The dip of the second seam is reversed.

It is probably the top of a decapitated fold, the two seams being really one and the same.

One of the most valuable deposits of Dyestone ore in the district occurs across the Tennessee river, twelve miles southwest of Kingston and nine miles south of Rockwood. A little mining town, called Ironton, has been built up at this place, which contains a population varying from fifty to one hundred. The ore is in a synclinal seven miles in length, lying in Roane, Rhea and Meigs counties. It outcrops in two lines, one on the east and the other on the west; the latter running through Half Moon Island and crossing the river below. Ironton is situated at the northern end of this synclinal, and a description of the manner in which the ore occurs and its general appearance at this place, will give a very good idea of the Half Moon Island region. At Ironton, the synclinal is only a few hundred yards across, the lines of outcrop, however, diverging as they extend south, like the edges of a yawl. The ore, regularly stratified, lies on both sides of a hollow, from four to six feet beneath the surface. The slope of the hill on the eastern side of the hollow is more abrupt and the ore dips at an angle of about thirty degrees. On the western slope, the dip is about fifteen degrees, thus making the synclinal with sides unequally sloped. On the western slope the ore lies in troughs running from the top of the slope to the bottom, forming a series of waves, or rather, decapitated folds. In the lowest parts of the great synclinal, the ore disappears or gives place to a limestone. At Ironton, the ore is highly fossiliferous, of a very dark brown color, indeed almost black, disintegrates rapidly by exposure, yet is very free from calcareous matter. Ten thousand tons of merchantable ore is taken from an acre. The following are analyses of it:

Peroxide of iron.....	76.96
Alumina.....	8.04
Lime.....	1.09
Silica.....	9.53
Phosphorus.....	.49
Water, carbonic acid, etc.....	5.00
	<hr/>
	98.11
Metallic iron.....	51.77

Another analysis shows some variation :

Peroxide of iron.....	75.00
Alumina.....	6.81
Lime.....	.00
Silica.....	13.00
Phosphorus.....	.59
Water, carbonic acid, etc.....	4.60
	<hr/>
	100.00.
Metallic iron.....	52.50

At present half the ore worked at Rockwood is obtained at this place. Twenty miners are kept employed. The price paid for mining is forty cents per ton. The quantity raised by each man averages about $3\frac{1}{2}$ tons per day. At the time of my visit about 3,000 tons were lying piled up, awaiting transportation. The ore is carried by a tramroad one mile long, to the river, put on barges and floated down to Rockwood Landing. The price paid for delivery upon the cars at Rockwood Landing is two dollars per ton. It is understood that the Roane Iron Manufacturing Company have made a contract, to take effect in 1877, by which it is to be supplied with ore at \$1.50 per ton. The ore for this contract is to be dug about 250 yards south-west of Ironton. Here numerous shafts have been sunk, which reveal ore from four to five feet in thickness. The ore outcrops higher up the hill. A few hundred yards further south the ore is found in an old field, and at this point was worked before the war. On the margins of little streams below the old field it shows itself in great ledges, but these ledges near the water always have a considerable amount of calcite in composition.

Opposite White's Creek Island, which is just below $\frac{1}{2}$ Half

Moon Island, there is a great abundance of ore in the same synclinal and shows a thickness of from five to six feet. Near this point the synclinal crosses the river, and the ore is found on both sides; the river running for some distance in the synclinal.

The beds of ore on Half Moon Island and on the main land are extensive and valuable, and probably at no point in the State will they sooner be brought into service.

The fossil ores of Meigs county are very abundant, and are found in the same range of hills with Welcker's ridge and White Oak Mountain, and disposed in a similar way. These ores were worked in forges for many years.

Brown hematite also exists in large deposits on Ball Play creek, in Monroe county. This stream, a tributary of Little Tennessee, is near its mouth parallel with Tellico river and is separated from it by high ridges.

We have now passed over the most interesting iron regions in the Ocoee and Hiwassee districts. It remains before our trip is finished, to give a detailed account of the copper and coal districts.

COPPER DISTRICT.

The copper district of Tennessee lies in Polk county, in the south-eastern corner of the State. It occupies an elevated mountain basin 1770 feet above the sea, containing about forty square miles. Frog Mountain bounds it on the south-west. On the east and south-east great ridges covered with dark forests hem in the valley, while on the south the mountains melt down to low hills. The surface of Copper Valley is not smooth, but roughened by rounded hills, whose slopes are often studded with huge blocks of gneissoid rocks and metamorphic slates. Away from the smelting works these hills are not devoid of beauty, some of them being quite symmetrical in shape and covered with wild mountain grasses, and in spring enameled with flowers of various hues. Near the furnaces all vegetation has been

MAP
OF THE
DUCK TOWN
COPPER MINES
POLK COUNTY,
TENNESSEE.

Scale 1 mile 24000 or 1"=2000.

• SHAFTS.

— ADIT.

FOR THE **BUREAU** OF
STATISTICS
AGRICULTURE AND MINES.
J. B. KILLEBREW Com. r.



HIWASSEE
TOWN.
FROM CLEVELAND
TENNESSEE.

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killed by the poisonous fumes of sulphurous acid gas that escapes from the works. The hills are bare and cheerless. A few dead trees stand in all their nakedness and present a picture of painful desolation and decay. For miles around, the country has been denuded of timber, which has been used in the manufacture of charcoal.

The Ocoee, which has already been spoken of, flows through the southern part of the copper district. Numerous small tributaries intersect the valley and cut deep gaps between the rounded gneissoid hills. The strata dip at high angles to the south-east, and the formation belongs to the metamorphic group of the Lower Silurian. Talcose and chloritic slates and micaceous schists abound, and at places good roofing slates occur..

The copper ores occur in three belts or veins, separated at intervals of a half a mile or more. The veins are capped by gossan, an impure siliceous brown hematite. Specimens of malachite and azurite are found just below the gossan. Black copper or Tenorite comes next, and lies with its top surface conformably to the contour of the ground. It is from two to eight feet thick, but nearly all this has been worked out. Iron pyrite and copper pyrite follow. The gossan is from 20 to 80 feet thick; black copper, 2 to 8; copper pyrite, unknown. Nine-tenths of the ore now worked at Ducktown are yellow copper ores or copper pyrite, a sulphid of copper and iron, having a brass yellow color, and when pure containing about 34 per cent. of copper; but as found in the mines, rarely exceeding four or five per cent.

At present there are three companies owning property in the copper district, viz:

1. Union Consolidated Mining Company.
2. Burra Burra Copper Company.
3. Polk County Copper Company.

Besides several individual owners.

Of these, the Union Consolidated Company only is at work. The mining is done mainly at the Mary Mine and East Tennessee Mine, both belonging to the Union Consolidated. (See map.)

Mary Mine.—This is situated three and a half miles south of the smelting works, with which it is connected by a narrow gauge railroad. This mine was opened in 1852. The black copper, which occupied a width of from six to forty feet, and a thickness of from one to ten feet, has been worked out for three quarters of a mile along the vein. Between 70 and 80 hands are kept employed at this mine. Common laborers receive \$1.06 per day; miners, \$38.25 per month. About 600 tons of yellow copper and 35 of black copper are raised every month. Drilling is done by contract, the rate paid being $2\frac{1}{2}$ cents per foot. For sinking shafts, \$155 per fathom is paid. The ore lies imbedded in a hard hornblendic rock. Gold, silver, zinc, galena, calcite, quartz, hornblende, molybdenite, actinolite, mispickel and iron are all found in small quantities, and iron pyrite in great abundance.

After being mined the ore is broken into small lumps and thrown into a stamp battery of ten stamps, each weighing 400 lbs., and falls by gravity a distance of ten inches. The battery is worked by a turbine wheel, driven by a small mountain stream. One and a half tons of ore per day is crushed by each stamp, or fifteen tons to the battery. The ore passes from the battery into the jigs, which separate the gangue from the copper. The Mary Mine is drained by a pump of 100 gallons capacity, driven by an engine of 40 horse power. The ores of the Mary Mine, which is in the eastern belt, are what are called basic ores and contain iron and lime with copper. The ores of the western belt are more siliceous, and have a siliceous slate and hornblende for a gangue. The ores of the middle belt contain more hornblende and quartz than those of the Mary Mine, and less than those of the East Tennessee Mine.

East Tennessee Mine.—This mine lies one mile north of the smelting works. The lowest depth reached is 470 feet. The quantity raised per month is 300 tons, nearly all yellow copper. About 4 per cent. of the ores raised are thrown away. Ninety-two men are employed in and about this mine. Drillers are paid 2 cents per inch. Powder is furnished by the Company, but the miners furnish their own lights. Six engineers are employed, one at \$45 per month, two at \$40, one at \$30, and two at \$1 per day. The Superintendent of mining operations is paid \$75 per month. The mine is drained by a pump driven by an engine of 25 horse power, which has a capacity of 100 gallons per minute, though about half its capacity only is required.

The containing rock or gangue of this mine is hornblendic slate, or sometimes siliceous slate. It is very hard and difficult to drill. The walls are not well defined, and the copper ores occur in small masses disseminated through the gangue, sometimes rich, often poor, rarely ever exceeding five or six per cent. A small quantity of black ore occurs in pockets, and sometimes a little native copper in bunches, distributed through decomposed quartz. At the present time the larger part of the ore is taken from the vein at the depth of 400 feet. All the ore is brought to the surface by steam, through a deep shaft. As the depth of the shaft increases, stations are established at certain distances, usually at intervals of 75 or 100 feet. From these stations tunnels are driven into the vein for the purpose of exploration or extraction. When a good body of ore has been reached by means of these tunnels, it is stoped out overhead and the ore carried in cars to the shaft. There are four or five of these levels established in the East Tennessee Mine, in each one of which more or less mining is done.

Louden Mine.—This mine lies a short distance west of the East Tennessee Mine. It has eight shafts and four adits. The eastern adit has well defined walls of talcose

slate. This vein has enclosed "horses" or pieces of wall-rock, which make "partings." From this mine was taken a deposit of black copper 70 feet wide and ten feet thick. It was called the "goose nest." The shafts vary in depth from 40 to 130 feet. Twenty-five men are kept employed. Miners are paid \$45 per month; drillers $2\frac{1}{2}$ cents per foot. None of the ores are smelted, however, the owner, Capt. J. E. Raht, having no smelting works at his command. The ores are thus disposed of: 1st. The poor mundic ores are carried to the Eureka Mine and roasted, preparatory to lixiviating them with water from the mine. 2d. The better ores are piled up to be smelted hereafter. These include the black ores and the better yellow ores.

Eureka Mine.—Nothing is done at this mine except pumping up the mine water and passing it through a long trough or channel that doubles on itself once or twice. In this trough scraps of wrought iron are placed, and the copper is precipitated from the water on the iron, the sulphuric acid of the copper uniting with the iron, forming the sulphate of iron, which runs off with the water, liberating the copper. Usually about one pound of copper is obtained for every two pounds of iron used. Wrought scrap iron is used in preference, because it contains no carbon or other impurities. Cast iron makes less than wrought iron, three pounds of that being required for every pound of precipitate copper. Wrought iron (scrap) costs delivered about $1\frac{1}{4}$ cents per pound. By this process of precipitation about 2,500 lbs. of metallic copper are collected every month. While the mines were worked, the amount of precipitate copper was as high as 9,000 lbs. per month. The Eureka Mine is the only one that furnishes water so saturated with copper as to make this process profitable. In this mine, where the ore is exposed, oxidation is going on at a rapid rate. The heat generated in the mine is so great that a person is scarcely able to pass through.

The precipitate copper yields about 80 per cent. of refined copper. The pump which brings up the water from the mine is driven by a water wheel having a shafting one-eighth of a mile long.

Polk County Company's Mine.—This is not worked at present, but formerly produced a large amount of black copper. Experiments made with the diamond drill showed good yellow ores. This Company had four blast furnaces, and two reverberatory furnaces, besides an interest in the refining works of the Union Consolidated Company.

Burra Burra Company.—This Company commenced operations in 1859, but met with serious losses and had to suspend. The first copper found in the district was on the lands which now belong to this Company. Upon the property are four blast furnaces, two calcining furnaces, and two shafts—one 240 feet deep, and the other 400. The ores are thought to be very good, mostly yellow ores.

Tennessee Mine.—This was worked for four or five years for black ores only, after which the property became the subject of litigation, and at present the court charges and lawyers' fees will probably consume its entire value. Originally this was school property, and was valued at one time at \$200,000. The School Commissioners leased it to a Company for an annual sum, which was to go to the support of the public schools. The action of the Commissioners was not sustained, and to get the property transferred back to the original owners required the expenditure of its entire value.

The vein on this property is three-quarters of a mile long. The black ores are now exhausted, and the mine has no future, with its overshadowing indebtedness.

An opening has been made upon a tract of 80 acres belonging to Col. Irby Boyd, and adjoining the Union Consolidated and Hiwassee Mines, which shows a good deposit of black copper, yielding 18 per cent. This is in the middle belt.

The smelting works of the Union Consolidated Company consist of 12 shaft furnaces, 2 reverberatory, and 2 roasting furnaces. The process employed for the separation of the copper is long, tedious and complicated. It is a combination, in part, of the English and German methods. The ore goes through six operations, the object of each being to eliminate some part of the substances with which the copper is combined. Prof. Lupton, of the Vanderbilt University, thus describes the process:

"The ore is subjected to six different operations, some of which have to be repeated. When taken from the mine it is first dressed, that is taken into small pieces and assorted. The reduction embraces: 1. Ore roasting. 2. Ore smelting. 3. Matte roasting. 4. Matte smelting. 5. Blister smelting. 6. Refining.

1. *Ore Roasting*.—This is done by simply placing two or three layers of seasoned wood on the ground, and piling the ore on this to the height of three or four feet. The wood is set on fire around the sides and by its slow combustion furnishes sufficient heat to burn a large portion of the combined sulphur. The roasting process is repeated, requiring each time about one month for its completion.

2. *Ore Smelting*.—The roasted ore is smelted in a shaft or cold blast furnace of very simple construction. The shaft is about twelve feet in height and two feet square. The ore with common charcoal is put in at the top, usually about twenty pounds of coal to sixty pounds of ore, the proportions varying with the richness and quality of the ore. The slag—an impure sulphide of iron—which settles to the bottom, floats on top of the impure metal, and is drawn off into conical-shaped pots. Should any copper be drawn off with the slag, it settles in the small part of the cone, and is easily separated from the solidified slag.

3. *Matte Roasting*.—The crude black copper, called matte, gotten from the ore smelting, contains a large pro-

portion of iron, sulphur and other impurities. It is now subjected to five successive roastings, by being placed on wood, as in ore roasting. This repetition of the process concentrates the copper, and renders it more suitable for smelting.

4. *Matte Smelting*.—The roasted matte is smelted in a blast furnace, with the addition of black or siliceous ore in sufficient quantity as a flux.

5. *Blister Smelting*.—This consists in melting the smelted matte in a reverberatory furnace, and allowing a current of air to pass over it, in order to further oxidize the iron and sulphur. The iron slag formed floats on top of the melted copper, and is easily scraped off. The copper, which has now become nearly pure, is known as blister copper, and requires one more operation to complete the reduction.

6. *Refining*.—The last, or refining process, is done by simply melting the blister copper in a reverberatory furnace, and poling or stirring it with green poles, the organic matter of which reduces any oxide of copper, and burns off the last traces of sulphur. The purified copper cast into ingots is now ready for market. During the process of washing, heavy white fumes are emitted consisting chiefly of sulphurous acid, which are destructive to vegetation within the vicinity of the works, and are by no means healthful to the workmen."

About five hundred men are employed about the copper mines. Many more find employment in the country around in cutting wood or converting it into charcoal. Much of the wood is obtained twenty miles or more up the Ocoee, and floated down to the coaling yard near the Mary Mine. The wood is cut and put in the river twenty miles above, at one dollar per cord. The Company takes charge of it from the time it is launched. Two or three men are employed with canoes and spike poles to dislodge all that may drift against islands, rocks, or other obstructions. Near

the coaling yard a pontoon bridge has been constructed with nets to catch the wood. The wood, as it comes down the river, is caught and drawn upon the bridge, and from thence hauled to the coaling yard. The cost of the wood is variously estimated at from \$2.00 to \$3.00 per cord, delivered on the yard. Charcoal costs from six to seven cents for five peck bushels, the former price being paid for small lots and the latter when furnished in large quantities. The item of hauling is a considerable one. Not only has all the charcoal or wood to be hauled from six to ten miles, but all the copper has to be carried in wagons 42 miles to Cleveland.

The Consolidated Company has $5\frac{1}{4}$ miles of narrow gauge railroad; width of tract 3 feet. The railroad connects the Isabella Mines, (not now worked, but upon the lands of which the smelting works are built), with the Mary Mine, and the woodyard beyond. It also passes by the smelting works to the East Tennessee Mine, one mile further north. If a railroad should be constructed to run from Cleveland through the copper district to Marietta, Georgia, and there connect with the Murphey (N. C.) Railroad, now building, the profits of the mining operations at this town would be very greatly increased. And this profit would result from the sulphurous acid gas that is now dissipated in the air, greatly to the injury of the surrounding vegetation. This could be cheaply converted into sulphuric acid, and a market, by means of such a railroad, found in Charleston, S. C., where it is largely in demand for working up the beds of phosphates into commercial fertilizers. Copperas, also, could be made on a large scale, and with ready means of transportation might be made profitable.

The copper region labors under great disadvantages in consequence of its distance from market, and a want of such facilities. And first among these is the distance that fuel has to be hauled. Wood at present, as before stated, has

to be brought from a long distance, involving an immense amount of trouble and time, in consequence of the ruggedness of the country. Supplies, too, for a large population have to be hauled in wagons from Cleveland, adding greatly to their cost and increasing *pro tanto* the cost of labor.

While there are inexhaustible supplies of yellow ores, they are very poor and will yield from three to six per cent. only. At the present price of copper, bringing in the New York market from 18 to 23 cents per pound, it may be readily seen that very close management and a rigid economy are necessary to make the business profitable.

Ducktown is a name which comprehends all the mining districts in the copper region. Hiwassee is the principal town of the region. It contains five or six stores, three churches, one hotel, and one school house, in which a free school is kept up for ten months in the year. One session of the Criminal Court is also held at this place, as well as at Benton, the county seat. This is done for the convenience of the people of Ducktown, Benton being thirty miles distant. Stores are at other places in the valley.

The soil of the copper region is very thin and unproductive. It consists, for the most part, of a micaceous sand, very thirsty and poorly adapted to field crops. By manuring, very good garden vegetables can be grown beyond the influence of the sulphurous fumes from the works. Most of the supplies are drawn from Cleveland and from the western part of the county, where there are areas of an abounding fertility.

LOOKOUT MOUNTAIN.

The only part of the district where coal is found is Lookout Mountain, which is an outlier of the Cumberland Tableland. It "lifts its awful form" 2,200 feet above the sea, and forms a striking feature in the landscape. It lies within three miles of Chattanooga, in a south-westerly direction, and is related geologically to the Table-land. It is

a synclinal fold, all the strata dipping towards the centre. It extends for many miles southward into Georgia, but its boldest ramparts are within a few miles of Chattanooga. In this mountain, so charming for its varied and impressive scenery, are found some thin seams of coal, but it has never been found in such thickness as to justify mining. Probably, however, there is no spot within all the district of which we have been writing, that is destined in the future to be more attractive to an intelligent population. The top of the mountain is comparatively level, and its elevation is such as to ensure a pure and invigorating atmosphere. The traveller in summer in passing from the torrid heats of the lower valleys to the airy height of Lookout, feels himself intoxicated by the healthfulness of the breezes, and inspired by the grandeur and beauty of the scenery. His limbs recover their elasticity and strength; his bilious habit ceases, and he enjoys an exuberance of spirits that denotes complete health. As a summer resort, it will in time become famous. Men of wealth will make their homes here and enjoy the delightfulness of the mountain air, the healthfulness of the chalybeate waters, and the glorious landscapes that extend into five States. The views embrace water, mountains, towns, fields, farm houses, forests, roads, and everything indeed that gives picturesqueness and beauty to the landscape. Standing upon the Point, one may see Chattanooga, the queen of the valley, lying as it were at the very base of the mountain. Girdling it on the east and south is Missionary Ridge, rendered famous in history by one of the bloodiest battles of the late war. Still beyond is the grand range of the Unakas, with its majestic sweep through four States—usually hazy in the distance, yet sometimes with peaks resplendent in the glories of a setting sun. The beautiful Tennessee, too, with its sparkling waters, can be traced in its course through many a mile. Far towards the mountains long stretches of it, like lakes of light, may

be seen gleaming amidst magnificent forests, sometimes hidden for many miles, then reappearing lower down the valley in long lines, enclosing sunny islands fringed by a circle of trees, whose dark shadows give a darker tint to the bright waters. Nearer and nearer it comes, sweeping now in grand convolutions, and rushing past the city with the majesty of a comet. When just beyond its limits, although unwilling to leave the city so soon, it returns on itself in a sharp curve like the toe and heel of a foot, and flows back for some distance, when it passes on between the butting crags of Walden's Ridge on the north and Raccoon Mountain on the south, and disappears. The Cumberland Table-land, with its frowning cliffs, may be seen as far as Cumberland Gap, one hundred and sixty miles distant. We do not propose to attempt to give a full description of the views of Lookout Mountain, but only to indicate the character of the scenery which is here afforded, because such things have their value in an economical point of view, and offer sometimes rare inducements for the investment of capital.

Upon the top of Lookout Mountain are waterfalls, natural bridges, rock cities, placid lakes, and other objects of curious interest to the lover of nature. Accommodations are afforded the year round to visitors, and the purity of the air is thought to afford great relief to persons of delicate lungs.

Chattanooga is the great commercial mart of the Ocoee and Hiwassee district. It is not intended to give an account of its trade and business prospects; but as a suitable spot for the erection of furnaces it deserves notice. It is situated at the very foot of the coal measures. The Tennessee river, that washes its walls, flows with its tributaries for more than 200 miles through the richest iron deposits of the district, and its western confluent cut great gaps into the coal formation, exposing seams of coal as thick as can

be found anywhere, making mining and transportation easy. The railroads which centre here from Georgia, Alabama, and from the Valley of East Tennessee, all pass over rich beds of iron ore. The Nashville & Chattanooga Railroad sweeps along the base of the Cumberland Table-land, the great depository of coal. Competition among the owners of mineral lands will always ensure cheap raw material for furnaces, while the river, after the Muscle Shoals obstruction shall have been removed, will forever be a guarantee against high freights to the north and north-west. The construction of the Cincinnati Southern Railroad will give the shortest routes to the coal and iron regions of the State, and to the markets of the west and north, and enable our iron masters to compete successfully with the most favored localities on the continent. Brown hematite iron ore, as well as specular, red and magnetic ores, can be obtained by the Western Atlantic Railroad in Georgia and Alabama, and brown ores by the Tennessee river from near the head of navigation of the Hiwassee, and by the Alabama & Chattanooga Railroad. The red ores can be procured also from localities just across the river, and at a hundred places up the river, as at Half Moon Island and Welcker's; or it may be had on the East Tennessee, Virginia & Georgia Railroad at White Oak Mountain, in James and Bradley counties; or from McMiun county, near Riceville. It may be obtained also from Sequatchee Valley, when the branch railroad from Jasper shall be extended; or from Hickman and Humphreys counties, even, when the Duck River Valley Railroad, now building, shall be running from Johnsonville to Fayetteville, and through, doubtless, to the coal fields. In passing through Hickman county, this road will pass by great deposits of rich brown hematites, unequalled in the State and unsurpassed on the continent. These vast fields of iron ore can all be made tributary to

Chattanooga, both by rail and river, after the Muscle Shoals improvement shall be made.

So much for iron.

Coal may be had from the Sewanee Mines, at Tracy City, from the *Ætna* Mines, and Battle Creek Mines, and Vulcan Mines in Marion county; from Soddy and Sale Creek, and other points in Hamilton; from the Dade Mine in Georgia, and from the coal fields of Alabama.

There is at present only one furnace in operation in the city, and its ability to keep running during the present period of stagnation and depression, is the best argument in favor of Chattanooga as a suitable point for the erection of blast furnaces. Here, almost every species of ore can be obtained, and by judicious mixing, any quality of iron can be manufactured which the demands of the trade may call for. This, taken in connection with the further fact, that the ores are not only rich but cheap, costing delivered less than one-fourth what is paid for the same quality of ores in Pittsburgh, will serve to explain why a furnace in Chattanooga, with a limited capital, can run at profit, when nearly all the furnaces about Pittsburgh have blown out or are running at a loss.

The prices for red ore at the Chattanooga Iron Company's Furnace this year have been as low as \$1.60 delivered; coke from 9 to 9½ cents, payable in pig iron at \$25 per ton; limestone, 2,250 lbs., delivered at \$1.00, which analyzes from 93 to 94 per cent. carbonate of lime. For most of the red ore used, from \$2.00 to \$2.32 per ton delivered was paid. Much of it was obtained from Attalia, Ala., which analyzes as follows, according to William J. Land, Chemist:

Water.....	3.95
Metallic iron.....	54.21
Oxygen combined.....	23.23
Silica.....	15.40
Phosphorus.....	.43
Undetermined.....	2.78

The yield from this furnace is even greater than the analysis, being 55 per cent., free of silica, as the following analysis by the same chemist will show :

Metallic iron.....	94.40
Carbon.....	3.58
Phosphorus.....	.81
Sulphur.....	.13
Undetermined.....	1.28

The sulphur comes from the fuel.

When the furnace is in good running order, about forty of the following charges are made every 24 hours, viz. :

Ore.....	2,600 lbs.
Coke.....	1,800 lbs.
Limestone.....	900 lbs.

The result is from 20 to 22 tons of pig iron—mainly foundry No. 2. Scrap is not counted. Mill iron can be made with 67 bushels coke per ton.

Hands are paid in money from \$1.00 to \$1.25 per day, for 10 hour and 12 hour hands.

Engineer, per day.....	\$2.50
Assistant, " 	1.50
2 Engineers for hoisting engine, each.....	1.50
2 Keepers, per day, each.....	1.75
2 Helpers, " " 	1.25

No salaried officers except book-keeper.

Some of the ore was procured across the Tennessee river within a mile and a half of the furnace. The ore from this place is rich in metallic iron, but difficult to mine, owing to its softness and its tendency to crumble and mix with the interstratified shale and clay. The following is an analysis of it:

Silica.....	12.10
Sulphur.....	.15
Water.....	4.00
Oxygen combined.....	24.00
Metallic iron.....	56.00
Phosphorus.....	.42
Undermined matter.....	3.36

The following freights were paid by the Company for shipping iron by the car load to the points mentioned :

	PER TON.
From Chattanooga to Louisville, Ky.....	\$3.36
“ “ to St. Louis, Mo.....	5.47
“ “ to East St. Louis, Ill.....	5.15
“ “ to Cincinnati, Ohio.....	5.11
“ “ to Indianapolis, Ind.....	5.11
“ “ to Springfield, Ill.....	5.00
“ “ to Greencastle, Ind.....	5.16
“ “ to Nashville, Tenn.....	1.51
“ “ to Evansville, Ind.....	3.62½
“ “ to New Albany, Ind.....	4.16
“ “ to Terre Haute, Ind.....	4.66
“ “ to Memphis, Tenn.....	3.00

Since the statistics given above were collected, we have the following note from Col. S. B. Lowe, an extensive iron dealer at Chattanooga. The figures given will doubtless be of great interest to iron merchants generally :

J. B. KILLEBREW :—Dear Sir—Your letter of inquiry received. The grades and price of the Chattanooga Iron Company's iron is as follows :

White and Mottled	\$14 @ \$15
Gray, mill.....	\$15 @ \$16
No. 2 Foundry, (close).....	\$17
“ “ “	\$18
No. 1 “	\$19 @ \$22 50

Freights from Chattanooga to the several points enumerated, is as follows, viz :

	PER TON.
From Chattanooga to Louisville,.....	\$3.36
“ “ to Bellville,.....	4.67
“ “ to Nashville,.....	1.51
“ “ to Cairo,.....	3.41
“ “ to Chicago,.....	6.31

From Chattanooga	to Cincinnati,	4.56
"	to Cleveland,	7.06
"	to Columbus,	5.61
"	to Dayton,	5.46
"	to Detroit,	7.11
"	to Springfield,	5.00
"	to Evansville,	3.57
"	to New Orleans,	5.56
"	to Rochester, Minn.,	12.91
"	to Topeka, Kansas,	9.17
"	to Vicksburg,	5.60
"	to Kansas City,	7.60
"	to Jackson, Miss.,	5.30
"	to Holly Springs,	4.64
"	to Keokuk,	7.22
"	to Huntington, W. Va.,	5.56
"	to London, Canada,	8.41
"	to Michigan City,	6.01
"	to New Albany,	3.76
"	to Racine, Wis.,	7.81
"	to St. Thomas, Canada,	9.31
"	to Memphis,	3.00
"	to Toronto, Canada,	9.11
"	to Wheeling,	8.01
"	to Philadelphia,	8.10
"	to New York via Norfolk,	8.56
"	to " " " Charleston(sail)	5.35
"	to Boston,	8.80
"	to Richmond,	6.00
"	to Washington,	7.50

Besides these we have rates upon some two or three hundred minor points in about the same proportion as those already given.

Respectfully,

S. B. LOWE.

Iron has been sold at Chattanooga for \$15.50 per ton at the furnace and a profit realized. During the latter part of last year and the beginning of this the prices ranged from \$16.50 to \$18.00 at four months. Every thing except coke is paid for in cash. If bought for cash, coke can be had delivered at 6 cents per bushel. We leave for others to figure out the cost of manufacturing pig iron at Chattanooga, merely remarking, that this Company has thrown out every man who does not make an efficient and profitable worker.

Besides the blast furnace there are two rolling mills at Chattanooga, and another in process of erection. The one belonging to the Roane Iron Manufacturing Company is the only one at work. This employs 500 hands and has a capacity of 30,000 tons of railroad iron per annum. Its annual sales amount to \$1,650,000. It is probably the only rolling mill in the country that has this year declared a legitimate dividend.

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